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U. S. DEPARTMENT OF AGRICULTURE.

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# INSECTS INJURIOUS IN CRANBERRY CULTURE.

BY

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## LETTER OF TRANSMITTAL

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U. S. DEPARTMENT OF AGRICULTURE,  
DIVISION OF ENTOMOLOGY,  
*Washington, D. C., June 29, 1903.*

SIR: I have the honor to transmit herewith an article on Insects Injurious in Cranberry Culture, prepared by John B. Smith, professor of entomology, New Jersey Agricultural College, and recommend that it be published as a Farmers' Bulletin.

Respectfully,

L. O. HOWARD,  
*Entomologist and Chief.*

Hon. JAMES WILSON,  
*Secretary of Agriculture.*



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# INSECTS INJURIOUS IN CRANBERRY CULTURE.

## INTRODUCTION.

The method of cultivating cranberries is so radically different from that employed for any other crop, and the character of the soil on which the plants grow is so unlike that on the ordinary farm, that it is not surprising to find the insect enemies more or less peculiar in character and the methods of dealing with them unusual.

The general practice is to cover the bogs with water during the winter, and this excludes from them quite a variety of insects that might otherwise prove troublesome. In a few localities where winter flowage is impossible, some insects that are not usual on other bogs do injury, and these must be dealt with as similar species would be treated if affecting upland crops. With a bog properly located, properly laid out, and a suitable amount of water supply to cover it promptly in case of necessity, the cranberry grower need fear none of the insect pests so far known as injurious to the crop.

Roughly speaking, the species of insects injurious to cranberries are divided into such as affect the foliage, such as attack the stem, and such as injure or destroy the fruit. Under the first head come the leaf folders, like the black and the yellow head cranberry worms, the tip worm, and the different spanworms which appear in variable numbers each year. Under the second head comes the stem girdler, which eats the bark of the stem or runners and thus kills the plant beyond the point of attack. Under the third head comes the berry worm and the various grasshoppers and katydids that eat of or into the fruit.

## INSECTS THAT ATTACK THE FOLIAGE.

### THE BLACKHEAD CRANBERRY WORM.

(*Eudemis vacciniana* Pack.) <sup>a</sup>

This is perhaps the best known and most uniformly injurious of all cranberry insects and is locally known as the "vine worm" in Massachusetts and as the "fireworm" in New Jersey. As a larva (worm) it is a deep, rather velvety, green, slender little caterpillar, not over

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<sup>a</sup> Also mentioned in entomological writings as *Anchylopera* and *Rhopobota*.

half an inch long when full grown, and with a shining black head and neck. The adult is a small moth or "miller" with narrow, dusty-brown wings that measure less than half an inch when expanded and seem much smaller because they are so slight. More closely examined



FIG. 1.—Moth of blackhead cranberry worm (after Riley).

the fore wings will be found to have alternate light and dark gray-brown shade bands, obliquely arranged as shown in fig. 1.

The moths first appear on the bogs in early June, continuing until nearly the end of the month, and again late in July, continuing into August, when they disappear for the season. During the day little is seen of them unless the vines are disturbed, when they flutter away for a short distance, concealing themselves so closely as to be almost undiscoverable unless the actual point of settling has been noted. In the early evening and until the darkness sets in fully they are on the wing and hover a short distance above the plants like a swarm of mosquitoes.

Though the moths themselves have disappeared for the season before the end of August, they have left, scattered everywhere on the undersides of the leaves, their minute yellow eggs (fig. 2). These eggs are flattened, disk-like, and less than half the size of an ordinary pin head, but their bright yellow color makes them easily visible against the green of the leaf, even without a magnifier. There they remain throughout the winter, whether the bog be dry or flowed, and the little caterpillars hatch from them in spring as soon as the temperature reaches an average of about 60 degrees. Many of the eggs perish during the winter, but where the vines are uncovered in sheltered spots they hatch out little worms about the time the vines themselves



FIG. 2.—A cranberry leaf, showing eggs of blackhead (after Smith).



FIG. 3.—First web of larva of blackhead (after Smith).

are making a start. For a day or two the worms nibble on the under surface of the old leaves or may even burrow into them and then make their way to the tip of an upright, where they spin together the edges of the new leaves.

The experienced grower, if he walks among his vines a few days after they have made a start, can tell at a glance to what extent his bog is infested by the closed tips (fig. 3) that are prominent because the light undersides of the leaves are visible. In about three weeks from the date of hatching, the caterpillar is full grown, lines the inside of its shelter more fully and closely with fine silk, and changes to a stubby little yellowish-brown pupa (fig. 4). In a week the transformation is com-

pleted and the moth appears about the 1st of July. The bog at the beginning of July shows very plainly the effects of the insect's attack in brown tips that are everywhere noticeable; and every brown tip at this time means a barren upright.

Next the leaves drop and the burnt appearance disappears for a few days, but this is only to give way to another series of spun-up tips which resemble those of the early brood, but with a difference. The vines are now in full foliage, full of buds and almost ready to bloom. Unlike those of the first brood, the worms of this second brood are not content to spin up only a single tip; they gather into their web everything within reach (fig. 5).

Two or three sprays with all their buds may be included and every chance for fruit destroyed. In fact, the buds, flowers, and very young

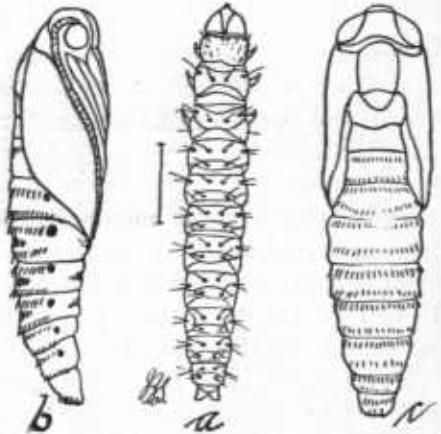


FIG. 4.—Blackhead cranberry worm; a, larva, b and c pupa—enlarged (author's illustration).

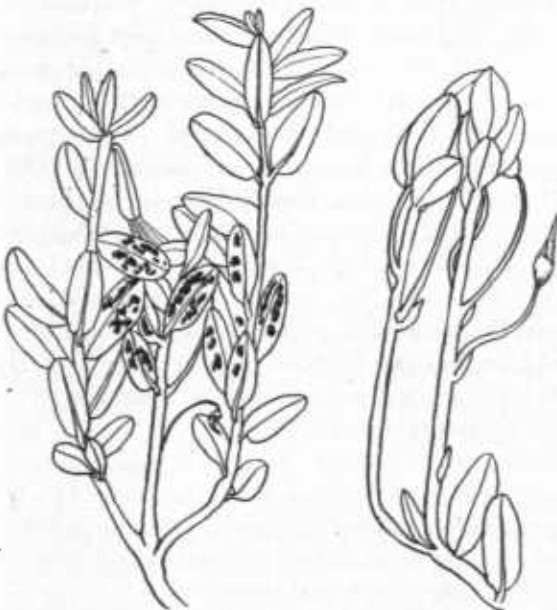


FIG. 5.—Examples of feeding and of webbed uprights (author's illustration.)

(worms) mature in about fifteen days, and by the middle of July the moths are again out in full force. Egg laying is in full swing before the end of the month and these eggs do not hatch till the next

berries are eaten by preference, and the injury to the crop is out of all proportion to the amount of plant tissue actually devoured. So, also, instead of eating up a leaf entire, the worms take a few bites here and there until, toward the end of July, the bog appears as if it had been burnt over, justifying the term "fire-worms" for the insects.

The egg stage for this second brood is less than a week in length, the larvæ

year. The cranberry vines will recover in appearance, and by the middle of August look green and flourishing; but if the worms have been numerous there will be no berries.

**Remedies.**—The question of remedial measures will be considered after the description of the next species, as the two need similar treatment.

### THE YELLOWHEAD CRANBERRY WORM.

(*Teras minuta* Rob.) <sup>a</sup>

This insect is much more abundant in New Jersey than it is in Massachusetts, and in some localities in the latter State it does not seem to occur as a cranberry feeder at all. It is quite as plentiful on Long Island as it is in New Jersey, and wherever it occurs is apt to be even more injurious than the preceding species.

The common name here used describes the most conspicuous difference in the larval (worm) stage from the preceding species, and is employed in preference to the term "vine worm" under which it used to be best known in New Jersey. In this species the eggs are not on the bogs during the winter. On the contrary, the moths themselves hibernate in any shelter they can find—in cranberry houses, barns, or other buildings; under bark or bark scales on trees, and in numerous other places where they may find protection from the direct influence of the weather. At this season the moths are uniformly slate gray, inconspicuous, much broader winged than the moth of the "black-head worm," and apparently much larger in every way. They are on the wing as soon as vegetation starts in spring and are ready to lay their eggs during the latter part of April and early May. They prefer cranberry if they can get it; but if not, make a shift with huckleberry or some allied plant, or even with apple. Wherever cranberry vines run up on the dams above the water line, or are otherwise not submerged, eggs are laid on the underside of the leaves. These eggs resemble those of the blackhead species so closely that, except for their fresher, brighter appearance, no differences can be observed even with a good hand lens. By the middle of May in New Jersey, and perhaps a little later in Massachusetts, all the moths have disappeared. This habit is an important one from the practical point of view and gives in some localities practical control of the insect. The eggs hatch in a week or ten days—depending much upon the weather—the worms make their way to the tips and spin together the terminal leaves, exactly as do those of the preceding species. The yellow head is practically the sure mark to tell this kind from the blackheads.

<sup>a</sup> Treated in works on economic entomology, also, as *Teras vaccinivora* Pack.

This matter of distinguishing between the two is of decided importance, because, while the feeding habits are similar, there are vitally important differences that affect remedial measures. The yellowheads are, on the whole, stouter than the blackheads, and, as a rule, lighter in color. They are also less active and, especially when nearly full grown, do not so readily wriggle out of their nests.

The yellowheads grow fast, and are ready to pupate late in May or very early in June, a little before the blackheads. The second moths appear early in June, but are now bright orange red in color, whereas the first moths were slate gray. The second lot of eggs hatch toward the end of June, and the yellowhead worms are nearly half grown when the cranberries are in full bloom, early in July, when the second brood of blackheads has just started. They make even larger webs than the blackheads, and are even fonder of boring into the fruit. It is not uncommon to see half a dozen uprights and runners all tied together in one large web, in which leaves, even if not eaten, turn brown and die. By the middle of July or a little later the yellowheads are again full grown and change to pupæ. The worms spin a silken cell, in which the change takes place, and the pupa (fig. 6) is dark brown or blackish, with a little knob-like protuberance on the head case. This peculiarity makes the species easily distinguishable from the same stage of the blackheads.

The third crop of moths appears late in July or early in August and are of the same orange-red color as the second. Eggs laid by these moths do not hatch until in August or even early in September, and the worms that come out of them grow slowly as compared with the earlier broods. Few of them spin up more than a single shoot and few of them eat into any but the smallest berries. They also tend to become reddish in color and even striped, so that at one time they were believed to form a distinct species, described as the "red-striped cranberry worm." Not until after the picking, if anything be left to pick, do these worms become full grown. Very irregularly in late September and early October they come to maturity, and now the moths that come from them are, after a dust of orange wears off, of the slate-gray color seen in spring.

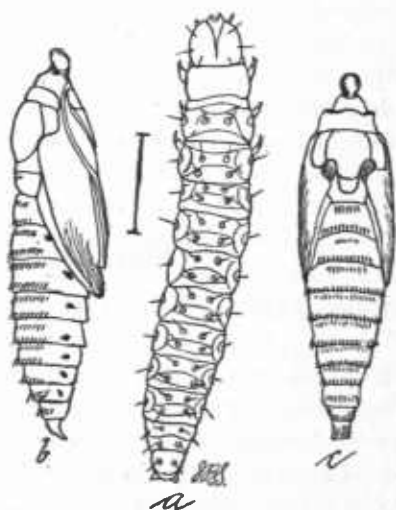


FIG. 6.—Yellowhead cranberry worm; a, larva; b and c, pupa—much enlarged (author's illustration).

### NATURAL CHECKS.

The blackhead worms are little, if any at all, subject to parasitic attack. The check for these seems to come in the mortality among hibernating eggs. Only a small fraction of those that are on the plants in midsummer survive to hatch during the following spring. But while the blackheads are kept within certain bounds by these natural conditions, they do very serious injury to the cranberry crop.

The "yellowhead" (Teras) is much more subject to parasites, though the first brood of worms is but little attacked. In the second brood matters have changed, and out of a given number of worms collected near maturity less than 50 per cent became adult. In the third brood conditions are yet further modified and not over 25 per cent of the worms develop to the adult stage, leaving, however, a goodly number to go into the winter. During this season many others die off because of adverse weather conditions, but still enough remain.

In general, on any given infested area, both of these cranberry worms will hold their own and even increase under natural conditions. The grower has nothing to hope for from the ordinary checks provided by nature.

### REMEDIAL MEASURES.

**Flowing the bog.**—The application of insecticides on large bog areas where the plants cover the ground as densely as do the cranberry vines is a task no grower likes to contemplate; and provided he has control of a satisfactory amount of water there is no necessity for it. As against the "yellowhead" (Teras), it will suffice if the water be held on the bogs until the middle of May, or perhaps a little later in cold seasons. By this time the huckleberry and heath plants have made a good growth and have tempted the hibernating moths to lay their eggs. Unless, therefore, the vines are uncovered at the edges or on knolls above water, the plants will be free from the first brood of worms. In the woods and on the upland plants the worms and even the moths are exposed to the attacks of birds and many predatory insects that never go upon the bogs; hence the adults of the first summer brood will not be nearly as plentiful as if they had bred on the vines. Only a few, comparatively, of the moths will fly upon the bogs, and even then do not usually get very far from the edges; so the heavy, very injurious middle brood will be reduced to practically harmless numbers. The third brood, even if it does spread over a greater area, is not likely to prove troublesome, for reasons already stated. Hence, care and attention to the drawing of the water in spring will of itself suffice to keep this insect in check. If to this we add the destruction of the heath and huckleberry plants immediately surrounding the

bogs, the nearby breeding places are further reduced and the bog is the more likely to remain free.

As against the blackhead late holding will not of itself suffice, because the eggs are already on the plants and will, under ordinary circumstances, hatch only under the same conditions that favor the start of vines themselves. But there is a little leeway in favor of the plants, and the eggs do hatch under water at a temperature not quite sufficient to start the vines. To hatch the eggs the proper temperature only is needed; to start the vines there must be also sun and air. If, therefore, a bog is tolerably level the water may be drawn from below until it just covers, and may be held there even after May 15, until the starting of the vines indicates that the danger point has been reached, and then it must be drawn to avoid killing the fruit buds. Runners or laterals not bearing fruit buds will stand a quarter or even half an inch start under water without danger unless the water is drawn on a very warm day, and then there is danger of scalding. The further advanced the plants the greater that danger becomes; hence great care and good judgment must be exercised when this measure is adopted. Fruit-bearing uprights can not be safely permitted to make more than a mere start. On a sloping bog, where the water is deep at the gates and becomes shallow at the edges, the water may be gradually drawn from the bottom so as to leave the warmer surface water, and in this way practically all the eggs will come under the influence of the moist heat that favors their development.

Carefully carried out, this measure is often very effective; the warmth favors the development of the embryo within the egg, and when the worm hatches it drowns. Occasionally a specimen may bore into a leaf and so maintain itself twenty-four hours or more, but usually it stifles without getting even a bite. Sometimes badly infested bogs are completely freed by this method without apparent injury to the setting of fruit, yet at times the crop is reduced one-half by holding a little too late. In the latter case, however, the crop had been destroyed by the insect for several years in succession, and the owner was quite willing to sacrifice 50 per cent if thereby he got rid of the insect, as he did. This method should be employed only when reflowing is not possible.

**Reflowing.**—When the supply of water is abundant above the bog area, so that a pond or reservoir may be formed, both the yellow and blackheads may be completely controlled by drawing the water early, waiting until all the eggs have hatched and some of the worms are nearly half grown, and then re-covering the bog with water for forty-eight hours. This method is so simple and so absolutely effective that the larger growers are adopting it almost universally, and few new bogs are laid out anywhere without considering the matter of reflowing and



providing for as good a control of the water as possible. Under proper control the water may be drawn from the bogs when the best interests of the plant demand it without any regard to insect conditions. If worms appear in any number toward the end of May, the bogs are reflowed, and rarely is this necessary more than once in three years. Only when the bog area is small and the surroundings are very bad is annual reflowage needful. For a complete effect the vines should remain covered forty-eight hours, because it requires some time for the water to penetrate the spun-up leaves so as to kill the worms. Many, indeed, especially the half-grown blackheads, wriggle out, seeking to escape when the water reaches them, but those nearing maturity are less active, remaining at home until the water surrounds them and they simply can not get out. Covering the bogs should begin in the late afternoon and should be completed before next morning, if possible. On a rainy day it may begin at any time, the object being merely to prevent the sun from boiling the young shoots. So drawing off the water should also begin in the early afternoon, and the bog should be practically dry the morning after. Incidentally, this reflowing will rid the bog of numerous other pests and may make a material impression on the girdle worm where that is abundant.

The importance of a sufficient water supply has come to be so generally recognized among advanced growers that in New Jersey miles of ditches tap streams far away from the bogs, and in Massachusetts expensive pumping machinery has been installed to raise water in large quantities to high-bog areas.

It is sometimes possible to use the upper one of a series of bogs as a reservoir, holding a full head of water as late as it is safe to reflow the lower bogs of the series which have been drawn early. In one series of 100 acres, divided into 5 sections by cross dams, a fall of about 10 feet is utilized to reflow all save the uppermost section, and this practice is possible in almost every case where water is available.

**Insecticides.**—Sometimes it happens that bogs can be neither winter flowed nor reflowed, and the application of insecticides becomes an absolute necessity. Only arsenites are to be relied upon for good results, although for a long time tobacco was and in some parts of Massachusetts is yet the main reliance. It follows from what has been said concerning the habits of the worms that when once they have spun up the tips and are feeding in their cases they are practically beyond the reach of our common insecticides; and that is particularly true of the first brood. If there is reason to believe from past experience, or because eggs have been found on the plants, that the early brood will be numerous, spraying must be done just as soon as the vines make a start or not later than the date when the first spun-up tip is seen. The object is to get the poison into position before the leaves are spun up, so that the worms may find their first meal poi-

soned. If spraying for the first brood is omitted, that for the second brood should be timed in the same way, and, because the worms now spin up a greater amount of vegetation, the chances of killing them off are greater.

All things considered, the best insecticides for use on cranberry bogs is arsenate of lead, either in the paste form as sold by certain makers of insecticides or made up by dissolving separately 4 ounces arsenate of soda and 7 ounces acetate of lead in water enough for that purpose, then combining the solutions in a tank to which 50 gallons of water may be added. If the paste arsenate is used, 1 pound in 40 gallons is better.

Any sort of machine or pump may be used and any nozzle that makes a reasonably fine spray. The point to be aimed at always is the terminal growth, because it is there that the insects feed. Nothing will be gained by driving the mixture into the body of the vines, especially if they are long and densely matted. The conditions on the bogs vary so much that every grower must determine his outfit according to his own needs. In some cases horses can be used on the bogs to draw a geared machine of large capacity; in others they are out of the question; and so the size of tank from which the spraying is done and the way in which it is mounted must vary according to circumstances.

It may under some conditions be more satisfactory to apply a dry insecticide, and for this purpose there are now several "dust sprayers" and "powder guns" on the market. By means of a fan blower a fine powder can be rapidly and evenly distributed over a large area, and this would naturally lodge just where it was needed. A good mixture for such application is 1 pound of fine Paris green to 10 pounds of dry hydrate or fresh air-slaked lime. The lime should be sifted, thoroughly mixed with the Paris green, and the combination applied while the vines are slightly moist.

### THE CRANBERRY TIP WORM.

(*Cecidomyia oxycoccana* Johns.)<sup>a</sup>

This is a minute orange-red or yellowish grub (fig. 7, *a*), about one-sixteenth of an inch in length, found in the growing shoots, whether uprights or runners. It is comparatively rare on Cape Cod and is not common on all the New Jersey bogs, though more plentiful there than anywhere in Massachusetts. It appears on the vines soon after they make a start, and the first indication of its presence is when the small leaves of the tip cease to unfold and become bunched into a compact, bulb-like mass. When this mass is opened, from one to five,

<sup>a</sup> Has been described and figured also as *C. vaccinii* Sm., not Osten Sacken.

and usually two or three, of the little grubs will be found at the very heart of the growing tip, feeding upon the juices and completely checking growth (fig. 8). If it is a runner that is attacked, it is destroyed; if a fruit-bearing upright, the flower buds come out below the infested tip and no harm is done to the crop. But the insects continue to appear on the bogs at intervals throughout the season, and the danger is that the late-tipped uprights will form no fruit buds for the next year.

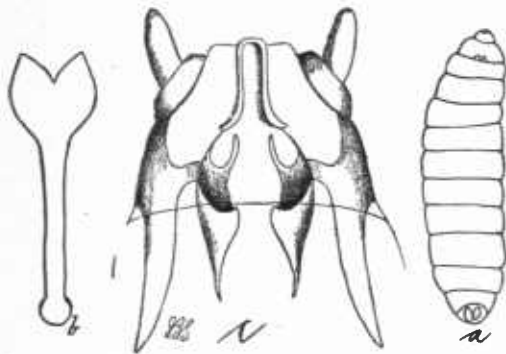


FIG. 7.—Cranberry tipworm; a, larva; b, breast bone; c, mouth parts—much enlarged (author's illustration).

The little grub is rather a helpless sort of a creature, without legs and even without distinct jaws; but it has on the underside of the body a little horny process or breast bone by means of which it scrapes the plant tissue until the cells break down and their contents may be absorbed. In about ten days it reaches full growth, envelops itself in a thin, white, silken cocoon,



FIG. 8.—Work of tipworm (author's illustration).

and two or three days thereafter changes to an adult—a minute, two-winged fly or midge whose wings when expanded measure less than an eighth of an inch from tip to tip. The male is quite uniformly yellowish-gray and inconspicuous, but the female has the abdomen

deep red, the upper surface of the body gray, the sides yellowish, the head and eyes black. She also has a slender, extensile tip to the abdomen, by means of which the minute white eggs are laid in the very heart of the bud.

After the fly has emerged from one of the infested cranberry tips the leaves that were massed together turn red or brownish, die, and break off, leaving a stub above the fully developed leaves. If the tips are killed early in the season fruit buds may form at the axils of the leaves, or one or more little spurs may start lower down on the shoot, at the tips of which normal fruit buds may develop. On new bogs, with young, vigorous vines, the early broods cause no damage at all and the late broods very little. On old bogs, with long vines, the earlier broods do little harm, but the later broods materially injure the crop prospects for the year following by preventing the set of buds on the injured uprights.

**Remedial measures.**—Strictly speaking, no direct remedial measures are known. It is not known positively how the insect passes the winter; hence control can not be attempted at that season. The worm never comes within reach of our ordinary insecticides, and therefore direct attack is not possible. Since the loss of the tips attacked in spring does not injure the crop of that year, the effort must be to keep the vines in such vigor that they will set fruit buds on laterals and at leaf axils when the direct tip has been lost. How this vigorous growth is to be obtained the grower will be best able to determine.

This insect is not confined to the cranberry, and in fact breeds much more abundantly on loose strife (*Lysimacha*) and on some of the heaths. Therefore, where the species is troublesome, those plants should be kept down on the dams and other bog surroundings. Tip worms occur on both flowed and dry bogs, and reflowing does not reach them; but as they first occur on flowed bogs around the edges, the inference is that the winter is passed on the upland, on or in some one or more of the alternate food plants. This would make the destruction of such plants an effective measure.

### THE CRANBERRY SPANWORM.

(*Cleora pampinaria* Gn.)<sup>a</sup>

In some sections of Cape Cod certain "span," "inch" or "measuring worms" occasionally become injuriously abundant, and the most destructive of these is the species above named. The parent moth is much larger than any of the other forms found on the bogs, the broad fore wings expanding  $1\frac{1}{2}$  inches or thereabouts. In general color it is pale ash gray, sprinkled with black, and both wings are crossed diag-

<sup>a</sup> Also known as *Boarmia pampinaria*, etc.

onally by black lines and shades. The lines have a tendency to become toothed or scalloped, and the wing margins themselves are also a little notched. The worms first appear on the bogs in June and become full grown by the end of that month or early in July. They are then rather more than an inch long; slender, smooth, livid gray caterpillars with a deeply indented head and a long, pointed anal plate. They have three pairs of short legs close behind the head and two pairs near the anal end. When they walk, they first stretch out at full length, take hold with the anterior legs, then bring the posterior pairs close to the others, the middle of the body forming a loop. This mode of progression gives them the common name "loopers" in addition to those already mentioned. At rest or when not feeding, the caterpillars hold fast by the anal legs only, and stretch out the remainder of the body at an angle, and so rigidly that they resemble leafless bits of vines. On a section of bog on which they have been feeding the observer may stand in the midst of thousands of them and see none until something starts them into motion; then it appears almost as though the entire bog was alive.

When full grown they bury themselves a short distance beneath the surface and change into rough, brown, rather stubby pupæ, from which the moths emerge a few days later. The second brood of caterpillars matures early in August, and pupation begins before August 9. Though worms will continue to be present in numbers until after the middle of the month, the moths appear at its end and in September.

There seems to be no regularity in the appearance of these insects. In some years they are not seen at all; in others they may be locally abundant, and only occasionally do they seem to occur everywhere in great armies. Usually they start from some point near the edge of the bog, spread out a little, and then move in an almost direct line ahead. Sometimes the beginning is nearer the center, and the eating may be in all directions from a given point where some groups of eggs were laid. It is the first brood which, as a rule, starts near the edges. The second brood starts from inside centers, and when these are numerous the boundaries of the individual broods become lost, and, the masses uniting, an army is formed which, as it advances, plays havoc with the crop. Not a green thing is left on the vines, and in a few days acres may change from green to brown; from a smiling promise of a full crop to the barrenness of desolation.

**Remedial measures.**—Being an open feeder upon the foliage, this span worm is susceptible to arsenical poisoning, and unless the bogs can be rapidly reflooded and as rapidly laid dry, spraying or dusting are the only alternatives. Where the worms are noticed when they first start, spraying the foliage just ahead of them may answer all purposes, and indeed this poisoning of their line of advance should always be done before treating the parts already infested. Either Paris green,

at the rate of 1 pound in about 160 gallons of water, may be used, or the arsenate of lead or a dry powder may be applied, as for the black-heads and yellowheads. So, also, the machinery to be used and the manner of application may be along the lines suggested on page 17.

#### OTHER CRANBERRY LEAF-FEEDERS.

Quite a number of species other than those already mentioned occur on cranberry foliage from time to time and cause local, though usually slight, injury.

The caterpillars of some of the "owlet moths" are always found in small numbers; but, except for the army worm, none have ever caused widespread trouble. As army worms can not live over on the bogs and must come on from the outside, a broad marginal ditch, well filled with water, will be a perfect barrier to their injury.

Spanworms are much more common, and the striking yellow and black larvæ of the white, chain-dotted geometer are sometimes as plentiful in New Jersey as in Massachusetts; but usually they are on bogs that run up into the huckleberry and heath bushes. They are not strictly cranberry feeders, but will run into the bogs when they become unusually abundant or when for any reason their normal food supply is scant.

Leaf hoppers of various species are more or less common always, and sometimes quite abundant; but, though they undoubtedly drain the plants to some extent, they seem to cause no injury to the crop.

Leaf rollers other than the yellowhead and blackhead cranberry worms are occasionally found. They usually make webs of such different forms that they are readily distinguished from the common species. None of them live exclusively on the bogs, and generally they do not appear until after midsummer.

A saw fly larva (worm) is sometimes found on New Jersey bogs and often eat little round holes in the young berries. It makes no sort of web and feeds only at night, its injuries being thus more readily found than the insect itself.

None of these species is of sufficient importance to demand more detailed notice here. As a rule the injury done is so slight that it will not pay to adopt remedial measures. If real damage is threatened, the arsenical applications are indicated except in the case of the leaf hoppers.

#### INSECTS THAT ATTACK THE STEM.

##### THE CRANBERRY GIRDLER.

(*Crambus hortuellus* Hbn.)

This species (fig. 9), more commonly known as the "girdle worm," is found abundantly in all the cranberry districts, but it is seriously injurious in Massachusetts only. The larvæ, which are slender, gray-

ish caterpillars, with shining, light chestnut-brown heads, and yellowish thoracic shields, pass the winter in a torpid condition within a silken tube or cocoon, which resists the entrance of water. In New Jersey the adults are found in May, on and around the edges of the bogs; in Massachusetts they do not fly until July, and there is evidence that the worms do some feeding in spring before they actually change to the pupal stage. This change to the pupa takes place in the tube or cocoon made in the previous fall, and on Cape Cod at the latter part of May or in early June. The adult is a pretty little creature, with fore wings expanding about three-fifths of an inch, and is one of the long-snouted moths, the palpi or mouth feelers projecting well beyond the head. The fore wings are rather narrow, very pale straw-yellow in color, with smoky lines in the interspaces between the veins and narrow silvery cross bands at the outer part, near the margin. The hind wings are much broader and of a uniform silvery gray. When the moth is at rest the wings are so closely wrapped around the body that it looks like a narrow whitish cylinder about three-quarters of an inch in length.

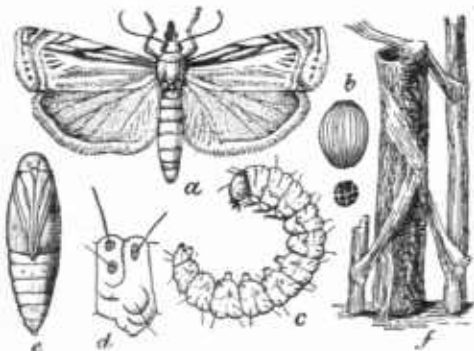


FIG. 9.—Cranberry girdler; a, moth; b, egg; c, larva; d, segment of larva; e, pupa; f, nest of larva—all enlarged (after Scudder).

clusters of new rootlets take their rise. Everywhere over an infested area, but especially along its borders, these worms can be found in filmy silken galleries following the prostrate stems of runners, into the surface of which they eat their way, destroying the vital part of the plant and, especially next to the base of the runners, deeply girdling the stem. They grow rather slowly, and not until November do they make their coarse cocoon of mingled sand and silk that serves as winter quarters.

It seems probable that in Massachusetts there is only one brood of the moths which is active in July. In New Jersey, on the other hand, the moths have been found in every month from about May 21 to the middle of September. There must be, therefore, at least two broods, which develop very irregularly. With this difference in the life cycle in the two States there is an evident divergence in food habits, for

there is no such destruction of large tracts in New Jersey as is found in Massachusetts. That the insect is not specifically a cranberry feeder is proved not only by the fact that it occurs not uncommonly many miles away from any cranberry plantation, but also by the direct evidence of an investigator who actually bred it on the common grasses and found further that the worms would eat freely of sheep sorrel. The cranberry feeding habit seems to be, therefore, a somewhat local characteristic and this gives hope that by persistent work this bog variety may be in large part stamped out.

An infested bog is rarely affected over its entire extent. Small areas varying from a few feet in diameter to half an acre or more are found here and there, and sometimes a little patch only a foot or two across will remain for two or three years in succession without becoming enlarged, but rather it will become closed up by runners from the adjacent healthy vines. Larger areas tend to become larger, new vines dying from the edges each year. A restart over areas so killed out is very slow, yet it does usually occur after the second year; but the growth is apt to be irregular and requires some time before it comes again into bearing condition.

**Remedial measures.**—It is quite obvious that insecticides are not available here, because of the concealed feeding habit, and that resort must be had to more direct methods. Light traps to capture the adults have proved unsatisfactory, very few specimens having been taken in this way. Experiments show that the worm in its silken case will bear submergence in water for over four days without fatal results, and it is known that in its cocoon it bears submergence during the entire winter. But the insect does not make this cocoon until November, and a submergence of five days immediately after the picking is completed destroys a great many. The suggestion is therefore made that, immediately after the fruit is off, infested bogs be flowed and be kept covered for at least a week, and better two weeks. This should be effective against these worms and harmless to the vines. While the ripening fruit is on, any water covering kept on over twenty-four hours would be apt to do material injury.

An additional suggestion is that the actually infested area be completely burned off as soon as its extent can be determined. The vines already attacked are doomed at best, and if in destroying them the insect can be also killed the loss will be balanced by a greater benefit. For this burning a gasoline torch may be employed, and the heat thus applied directly to the point where it will be most effective. The use of the torch will also prevent setting a fire that might injure other portions of the bog, since it can be used when the vines are so wet that they will not burn under ordinary conditions. The burned-over area can be immediately reset and the actual amount of injury limited to a minimum.



If burning is resorted to, it should be done as early in the season as possible and should be extended far enough to cover the entire infested portion of the bog.

## INSECTS THAT ATTACK THE FRUIT.

### THE CRANBERRY FRUIT WORM.

(*Mineola vaccinii* Riley.)

This is another species that is much more injurious in Massachusetts than in New Jersey, though it is by no means unknown in the latter State, and in some seasons and localities does considerable damage. As a rule, bogs that can not be reflowed and high and sandy bogs suffer more.

The adult moth (fig. 10) appears on bogs in ordinary seasons about the middle of July, when the berries are setting or have already set. It is probable that the moths remain on the bogs for a period of at

least a month, as indicated by the very unequal development of the worms that are found in the berries in early September.

The moth, with wings expanded, measures about three-fourths of an inch and is of a glistening ash-gray, mottled with white and blackish. The forewings are narrower than the hind wings, which are more smoky gray in color and have no markings.

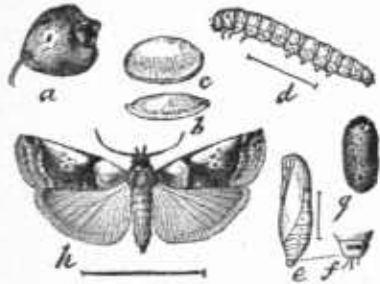


FIG. 10.—Cranberry fruit worm; a, berry, showing egg; b, c, egg; d, larva; e, f, pupa; g, cocoon; h, moth—all enlarged (after Riley).

It is a shy species, not easily started during the day, and flies with a darting motion for quite long distances. It is not generally recognized, therefore, even by growers who annually lose heavily by it. When at rest the wings are folded close to the body, and on a cranberry stem, where it usually rests head down, it is not readily seen even by an experienced eye.

The eggs are laid on the young berry, preferably in the calyx, just beneath one of the lobes, but they may be on any part of the berry and possibly on the leaves as well. They are very slightly convex, almost flat, round in outline, pale yellowish in color, and so soft that they adapt themselves readily to any inequalities of surface. The worms emerge in about five days, and for a day or two feed on the outer side of the berry. Then each worm enters a berry, eats out the seed chamber, and migrates to another. The vacated berry turns red, shrivels up, and eventually drops. The worm, on entering its new home, carefully closes the opening behind it with a web of fine silk, so dense that it is sometimes difficult to see where the hole was made. In this second berry it becomes half grown, then works out through a large

jagged opening and gets into a third berry, closing the point of entry as carefully as before. By this time the season is pretty well advanced, the fruit is of good size, and, soon after the worm starts feeding, the newly infested berry begins to turn red. To the ordinary observer the fruit is ripening nicely, if early; but the grower knows better and realizes that every such specimen is lost to him. Not unusually the worm completes its growth in this berry, but if it does not it eats into a fourth. This time it makes no attempt to seal up its point of entry; very often it spins together a little cluster of berries, eating from one into the other and ruining all of them. Full growth comes, as a rule, in late August or early September, just before picking time; then the caterpillar leaves the berry and in the sand at the base of the plants spins a rather close silken cocoon, in which it passes the winter. But quite frequently the worms do not get their full growth at picking time, and emerge from the berries after they are harvested and in the cranberry house. These delayed forms make their way to any crevice or other shelter that they can find and there spin up for the winter rest.

At this time the worm is rather more than half an inch in length, of a bright-green color, with a variably marked reddish tinge on the back. The head is a little narrower than the first body segment and is of a more yellowish color, except the mouth, which is brown. The body segments are transversely wrinkled, clothed with a few sparse, rather long hairs. As a whole, this is decidedly the stoutest of those occurring on the bog as injurious species.

The full-grown caterpillars winter in their silken cocoons, which they make by first rolling in the sand, gluing the particles together with saliva, and then spinning their web inside of the rough casing so formed. Pupation begins toward the middle of April with specimens that have been dry during the winter, but probably not much before the end of May or early June on the bogs. The pupa is brown, rather chunky, and of the same general form as in the species already described.

**Remedial measures.**—Winter flowage is not fatal to these insects, and covering the bogs with water at any time after the winter cocoon has been formed would probably be ineffective. Nevertheless, as already indicated, water-covered bogs are less troubled, and it is probable that the earlier the water is put on in the fall the more effective this practice will be.

Indications are that if a bog can be safely submerged for forty-eight hours between August 10 and 15, just before the worms reach their full growth, the great majority will be killed off. Sound berries covered for that length of time will not come to harm if the water can be put on and drawn off rapidly enough to avoid scalding. Fruits not quite so far advanced may be covered for even a longer time without injury, but there is always a risk which the grower should fully consider before he acts. The vines should be completely covered before the sun beats upon them high enough to warm the water, the covering

should be sufficiently deep to prevent a scalding effect, and when the water is drawn sunrise should find at least every berry above the water level, that the drying off may be gradual. A cool day would almost insure safety to the berries, an intensely hot one might cause injury, and the nearer maturity the fruit the greater the danger. Nevertheless, despite the danger, reflowage is advisable, provided it can be done within the time limit given.

If reflowage be not practiced, pick the crop as soon as it is at all practicable, so as to get as many wormy berries off the bog as may be. The worms will emerge in the cranberry house and form their cocoons in cracks and crevices or among rubbish. Give them plenty of shelter in the way of loosely piled slats, boards, or other cover, placed wherever conveniently possible, and any time during the winter clean up thoroughly, so as to reach the hibernating worms. Field mice will eat these worms. Also a liberal use of gasoline in such places under the usual precautions against fire would reach every one of them.

Insecticides are possible only during the two or three days in which the young worm feeds on the outside of the berry, and the only material that offers any chance of good results is arsenate of lead. If when the worm starts feeding it finds a poisonous meal prepared its career will be ended at once. It must be remembered that any application to be at all effective must be on the berries by July 10 and must be maintained there at least a month to get most of the hatching worms. Arsenate of lead is the most lasting of all the arsenical sprays, but new berries are being added constantly as new fruit sets, and at that season growth is rapid, so that a week will add a large amount of new, uncovered surface. One spraying per week for three, or preferably four, weeks offers a fair chance of success by killing off the berry worms before they get into the berry.

On bogs that can not be flowed the arsenate of lead, aided by early picking, will probably reduce the amount of injury materially; but on such bogs the development of the moths may occur earlier and the grower must rely more upon the stage of growth, or, better, the appearance of the moths themselves on the bog, than upon any absolute dates.

Methods of applying the arsenate and of preparing it have been already given on page 17.

### THE CRANBERRY KATYDID.

(*Scutelleria texensis* Sauss.)

One of the most destructive insects on the New Jersey bogs is a species of katydid (fig. 11), though its injuries are, as a rule, charged to grasshoppers in general. On Long Island the damage is less marked, and in Massachusetts the insect is practically unknown.

The injury is chiefly caused by the feeding habits of the adult of one species of *Seudderia* which chews into the berries when half to full grown, rejects the pulp, and eats the seeds. Other species belonging to *Microcentrum* and other genera have similar habits, but occur more rarely. The injured berries wilt, shrivel, and die; but when they have just been left by the katydids, the common, shorthorned grasshoppers feed on the exposed pulp and, being detected in this, are quite generally charged with having caused the entire trouble. One katydid may eat out several berries at one sitting, and when the insects are at all abundant the percentage of fruit destroyed is very large; on some bogs the amount reaches almost or quite one-half the entire crop.

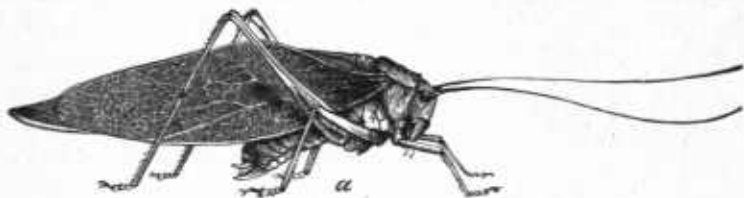


FIG. 11.—A cranberry-eating katydid (after Riley).

The katydids when mature are green, grasshopper-like insects, with very long antennæ, or feelers, and long slender hind legs. The fore wings are also green and are narrow, a little thickened, not used in flight. The hind wings are decidedly longer, much broader, very much thinner, almost transparent, and longitudinally folded under the fore wings when at rest. Fully expanded, these wings measure from 2 to 2½ inches between tips, and the body is about 1½ inches in length. In the male there is a little triangular area at the base of the fore wings where they overlap, and where a few ridge-like veins form a musical instrument by means of which they produce their chirping song or call. In the female this structure is absent, but we find at the end of the abdomen a broad scimitar or sickle-shaped ovipositor, by means of which the eggs are laid.

The young wingless katydids are found around and at the edges of the bogs about the middle of June, but do not mature until early in the following August. Not until they reach the pupal stage, after the middle of July, does the berry-feeding habit become developed, but from that time until the fruit is picked their fondness for this kind of food increases, and the insects themselves increase in number on the bogs. The first eggs are laid about the middle of September and the laying continues until about the same period in October. By that time the insects have disappeared and nothing more is seen of them until June of the following year.

The eggs are laid chiefly in two kinds of grasses, locally known as "deer grass" (fig. 12) and "double-seeded millet," scientifically re-

eord as *Panicum dichotomum* and *P. viscidum*, respectively, the latter being very decidedly the favorite.

The latter, *Panicum viscidum* (fig. 12), is a grass which grows in large tufts or clumps of from 20 to 30 stems, from 2 to 4 feet high, or perhaps 5 feet where it is found in thickets or fence corners. The whole plant is thickly covered with long, soft, velvety, somewhat sticky hairs. The stems are at first not branched and have from 8 to 10 leaves shaped like a narrow peach leaf, those at the top being very small. In summer and fall these stems branch from each joint and the branches keep on branching again and again, producing large numbers of small leaves and giving the plant a very bushy and tangled appearance. The seeds are borne in a small head at the top of each stem and later of each branch, these heads being something like a very small and loose sorghum head or more like a head of broom-corn millet or hog millet.



FIG. 12.—Tip of a spray of *Panicum viscidum*—reduced (after Smith).

*dum*, but is very much smaller, scarcely over 18 inches high, and growing in smaller tufts. The stems are slender and weak, and the plant is not at all hairy. It also branches freely in summer and fall. Where growing in the sunshine the stems are usually purplish.

Occasionally eggs are laid on other grasses or plants, but never on cranberry leaves. They are laid chiefly at night on the drier parts of the bog, in the edges of the leaf between the upper and the under surface, to the number of from one to five in one blade; the single number is much the more usual. When deposited the egg is very flat, almost three-sixteenths of an inch long, less than half as wide, slightly kidney shaped and of a very light yellowish brown color. The disk of the egg is closely and roughly marked or netted without definite pattern.

**Remedial measures.**—The character of the remedy to be adopted follows from the egg-laying habits of the species. Allow none of the host grasses to maintain themselves on the bogs and burn over the dams during the winter while the bogs are flowed. From the fact that the very young katydids are never found on flowed bogs except at the

edges joining the upland or at the base of the dams, it may be fairly inferred that the eggs do not survive the winter when kept completely submerged, so that destruction of the grasses above the water line might answer. It would be safer, however, to have the grasses out; they have no place on the bogs anyway.

For burning the grasses and other host plants on the dams some one of the gasoline torches now on the market may be used. They give a very intense heat and lick up leaves and plants with extreme rapidity. As they can be used against the wind or while the plants are somewhat damp there is practically no danger that the fire will get away, and when the ground is frozen, the covering of leaves and stalks is burned so rapidly that no heat gets to the roots. Growers consider it desirable to keep a cover of vegetation on the dams to strengthen or prevent them from washing, and this method will destroy the egg-bearing vegetation without also destroying the plants themselves.

### GRASSHOPPERS AND CRICKETS.

Numerous short-horned and long-horned grasshoppers may be found on and about the bogs, and more or less injury is charged to them. As to the common gray or brown short-horned grasshoppers the charge is believed to be practically unfounded. They do sometimes finish up berries that have been opened by the katydids; but direct evidence is lacking that they would or even could get into a sound berry. Nor do they occur in any numbers on clean, well-kept bogs, free from grass and from overgrown edges or dams. They belong naturally in the grassy undergrowth along the margins, and simply run over when there is an easy opportunity.

It is rather otherwise with some of the long-horned, green, meadow grasshoppers, which on grassy, reedy, or sedgy bogs are sometimes present in immense numbers. All of these are fond of seeds, and while the smaller species can not get into a half or full grown berry, the larger species can, and so they join the katydids in their destructive work, but in comparison do little injury.

Most of them have a long, flat ovipositor, straight or slightly curved, and they lay their eggs in the stems of the sedges, rushes, and larger grasses found on the bogs. None of these species can cut into leaves. Their eggs are long, slender, nearly cylindrical, and often just a little curved. They are laid in series of anywhere from three to eight, one above the other, the number of eggs in any series depending upon the length of the ovipositor in the species.

Where bogs are very full of these little species, a large proportion of the grasses and sedgy plants will be found bearing eggs, and these eggs are so well protected that they survive the winter though they be completely submerged. Accordingly, in early June thousands of

the little meadow grasshoppers are found just hatched and under such conditions that they could not possibly have come on from the outside.

**Remedial measures.**—The only way to keep these species off the bogs is to keep down the grasses. They are not naturally feeders upon the cranberry plant, and exact so small a toll that the actual loss is less than the probable cost of getting rid of them. If the grasses, etc., can not be readily taken from the bogs, they might be mowed, after picking, above the vine level. This would cut off the parts bearing the eggs, and as the loose grass would float when the water is put on, the eggs would either be carried to the edges or would decay with the vegetation containing them.

Crickets also occur in greater or less numbers on most bogs, and growers are by no means agreed whether they cause injury or not. That they will eat berries on the ground, especially under cranberry vines, is certain; but it is not proved that they ever go upon a vine to feed upon a berry attached to it. The species lay their eggs in sandy soil, and never in wet or mud land; so, as a matter of fact, no field crickets can really propagate on the bogs. But they get into the dunes, and oviposit in warm sandy places, so that the young may hatch early in the spring and find their way to the moist, warm places in which they delight. Their range of food seems to be wide, and there is almost nothing they will not eat under favorable conditions; but they live on the ground and rarely get out of the shelter of the vines or upon them.

If it be deemed desirable the crickets can be kept off the bogs almost entirely by broad, clean, marginal ditches maintained at least partly full of water. The crickets rarely if ever fly, and, while they are good swimmers, do not ordinarily attempt to cross any ditch 6 feet wide.

A flowing just after picking would destroy most of the grasshopper and cricket tribe that then occur in their greatest number.

### THE IDEAL CRANBERRY BOG.

So much has been said of bog conditions, and bog conditions so greatly influence the abundance of injurious species of insects, that it may not be out of place to describe briefly what a bog should be to make insect control easy and certain.

(1) The bog should be as nearly level as it can be made, so as to require the least possible amount of water to flow it. A bog that can be completely covered by a 12-inch head is better than one that requires 24, and when the difference in level of an area is 5 or 6 feet or more it is better to make two bogs out of it, that the lower may be reflooded from the upper and less than half the amount of water be required.

(2) Make no one bog so large that more than thirty-six hours are required to cover completely, and no more than twenty-four hours are required to draw the ditch level.

(3) Build a reservoir or reserve a flooded area above the level of the highest bog of a series sufficient to hold water enough to flow at least the highest bog completely. The importance of this requirement is so fully appreciated that miles of ditches have been dug in New Jersey to tap streams at a higher level, and many acres of swamp area have been created by raising contour lines to deepen natural basins. In Massachusetts powerful pumps have been installed to pour water directly upon the bog or into a reservoir above it.

(4) Adjust bog levels so that the upper one of the series can be completely emptied into the one below, and yet have the gates and outlets so adjusted that any one bog may be completely emptied without interfering with either those above or those below. It happens not infrequently that one bog needs cleaning or other attention while others do not.

(5) There should be a broad, deep, marginal ditch between the dam and the bog or between the bog and upland, and this ditch should be always clean and at least partly full of water. Many kinds of insects can be altogether kept from the bogs in this way, while grasshoppers and other insects are delayed until they can fly. Then they are feeding on other things, and they do not often change the food habits of their early life.

(6) The dams and the edges of the uplands should be kept as free as possible from vegetation that harbors cranberry-feeding species. Cranberry vines should not be tolerated for an instant. Huckleberry bushes are almost as bad, and these should be cleared back for some distance where bog and upland join without an intervening dam. Other heath plants are also undesirable and should not be allowed too near the bogs nor on the dams.

(7) It follows from what has been said that the bog itself should be kept as free as possible from all plants other than vines, certain grasses being especially objectionable because they are used by long-horned grasshoppers as places to lay their eggs.

Bogs so arranged could be kept completely safe at all times, and once properly laid out would require little outlay to keep them so. The question whether bogs should be kept wet or dry, whether there should be many or few ditches, and whether these should be deep or shallow need not be here considered at all. The dates of flowage and reflowage and other points of measurement by means of which control may be made effective have been already touched upon.

The important advantages are that neither insecticides nor spraying machinery would ever be required, and the insect problem would be reduced to the simplest possible terms.



## FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number, title, and size in pages of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. The missing numbers have been discontinued, being superseded by later bulletins.

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